

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without liability
for any use made thereof."

29T
E83-10295

CR-170326

LANDSAT-4 IMAGE DATA QUALITY ANALYSIS
FOR ENERGY-RELATED APPLICATIONS*



Principal Investigator: George E. Wukelic

Identification No.: 050

NASA/GSFC Order/Contract No.: 5-12402C

Co-Investigators: Harlan P. Foote
Louis M. Martucci
Frederick P. Brauer
Stephen C. Blair

Organization(s): 1) Pacific Northwest Laboratory (PNL)
Battelle Memorial Institute
Richland, WA 99352
2) In cooperation with other
Department of Energy Laboratories

Original from EROS Data Center
Sioux Falls, SD 57199

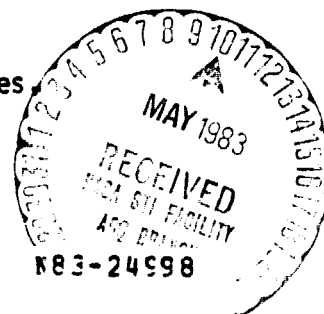
Original photography may be purchased
from EROS Data Center
Sioux Falls, SD 57199

FIRST QUARTERLY REPORT

April 11, 1983

PNL-4723

* Support provided by DOE Office of Basic Energy Sciences
Geosciences Program (KC-04-03-03, #87070)



(E83-10295) LANDSAT-4 IMAGE DATA QUALITY
ANALYSIS FOR ENERGY RELATED APPLICATIONS
Quarterly Report (Pacific Northwest Lab.)
11 p HC A02/MF A01

CSCI 05E

G3/43

Unclas
C0295

LANDSAT-4 IMAGE DATA QUALITY ANALYSIS
FOR ENERGY-RELATED APPLICATIONS

FIRST QUARTERLY REPORT
April 11, 1983

George E. Wukelic - Principal Investigator ID# 050

Objective/Scope: The objective of this investigation is to evaluate Landsat-4 Thematic Mapper (TM) data performance and utility characteristics from an energy research and technology perspective. The program focuses on evaluating applicational implications of using such data, in combination with other digital data, for current and future energy research and technology activities. Prime interest is in using TM data in efforts relating to the siting, development and monitoring of nuclear facilities. Secondary interests involve the use of such data for resource exploration, environmental monitoring and basic scientific initiatives such as in support of the Continental Scientific Drilling Program.

Approach: To utilize digital remote sensing/image processing and data integration techniques developed at the U.S. Department of Energy's Pacific Northwest Laboratory for processing, analyzing and evaluating Landsat-4 Thematic Mapper data. Data analysis and evaluation emphasis is on Landsat-4 data use for the Columbia Plateau region in eastern Washington in general and the Hanford site in specific. However, Landsat TM data for other representative energy research and production sites are being analyzed and evaluated as well. Table 1 identifies the main image data quality characterization areas of investigation and the prime application areas of interest.

Data Status: To date, no useable Landsat-4 TM data have been obtained for our prime study site in the Columbia Plateau region of eastern Washington

**ORIGINAL PAGE IS
OF POOR QUALITY**

**TABLE 1. PNL Landsat-4 TM Image Data Quality and
Utility Characterization Interests**

DATA QUALITY				
Geometry	Spectral Information	Detector Replacement Algorithms		
		Band Compression Algorithms		
	Radiometric Information	Internal Calibration Algorithms	Channel-to-Channel	
			Band-to-Band	
		Scene Histogram Calibration Algorithms (Radiometric Striping)		
		Absolute Scene Radiance Calibration Algorithms	Reflective Band	
			Thermal Band	●
Noise Correction Algorithms				
Radiometry	Geometry of Pixel	Ground IFOV		●
	Geometry of Image (Pixel Location)	Systematic Correction	Scan Profile	
			Detector Location	
			Between Scan Alignment	
			Epimerisms	
			Attitude	
	Geodetic Correction with GCPs	Reference Library Build		
		Scene-to-Reference Registration	●	
	Resampling			

DATA UTILITY		
Renewable Resources	Agriculture	
	Soils	
	Forests	
	Range	
	Irrigation	●
Non-Renewable Resources	Geology	●
	Image Science	●
	Other	
Planning/ Environmental Management	Regional/Urban Land Use	●
	Coastal Zone	
	Hydrology	●
	Wildlife Habitat	
	Oceans	
	Other	

state. Table 2 summarizes Landsat-4 data acquired to date and relational data sets being utilized.

Preliminary Results:

1. TMS Data Analysis. Prior to the receipt of Landsat-4 TM data, NASA ERL provided PNL with Thematic Mapper Simulator (TMS) data for a nuclear power plant (Virginia Electric Power Company-North Anna Plant) to test PNL image processing algorithms.

Principal component analyses of this data set clearly indicated that thermal plumes in surface waters used for reactor cooling

TABLE 2. Landsat-4 and Ancillary Data Status

	<u>Path/Row</u>	<u>Date</u>	<u>Comments</u>
1) Landsat-4 TM data			
<u>Prime Study Site</u>			
Hanford Site	Day 44/28		No useful TM data acquired
Richland, WA	Night 137/16		to date.
<u>Secondary Study Sites</u>			
Savannah River Plant (SRP)	Day 17/37	8/28/82	Received 1/31/83
South Carolina	Night 116/207	12/24/82	Received 3/28/83
Portsmouth Ohio Facility	Day 19/33	9/11/82	GSFC Processing requested 3/83
	Night 115/211		
West Valley, NY			
(Buffalo, NY scene)	Night 112/214	8/28/82	Received 11/15/82
<u>Test Data Provided</u>			
Northeast Arkansas	Day	8/22/82	Received 10/1/82
2) TM Simulator (TMS) Data			
North Anna Nuclear			
Power Plant	Day	9/11/81	Received 4/82 from NASA ERL
3) HCMM Data	Day/Night	12/17/78	Tapes for Savannah River
			received from GSFC 3/83
4) Ground Truth Data			
Savannah River Plant	On Site	8/28/82	Also aircraft MSS (including
	Thermal	& 12/24/82	thermal) over SRP 9/82 and
			2/83

would be discernible. Figures 1 and 2 show the results of the TMS data analysis. Figure 1 is a conventional IR color composite (using TMS bands 1, 2 & 4) and Figure 2 shows the TMS thermal composite (using bands 5, 6 & 7). The thermal band on the TMS data was, however, not resampled to simulate the 120 meter TM band 6 data.

2. Landsat-4 TM Data Analysis. Shortly after the launch of Landsat-4, PNL image processing and analysis programs were successfully tested using the 7 band Arkansas test scene for August 22, 1982 (path 23/ row 35) provided by NASA GSFC. Upon receipt of the first requested TM data set in January 1983 for the DOE Savannah River Plant (SRP) in South Carolina (Augusta, GA scene for August 28, 1982, path 17/ row 37), preliminary analysis clearly indicated that current interactive, image enhancement, analysis and integration techniques can be effectively utilized for Landsat-4 data analysis and utilization. Moreover, thermal band data appear adequate for gross estimates of thermal changes occurring near operating nuclear facilities especially in surface water bodies being used for reactor cooling purposes. These qualitative results are documented in Figures 3 through 5.

Figure 3 is a map showing operating nuclear facilities and associated surface waters used for reactor cooling at the Savannah River Plant. Figure 4 is a TM IR color composite of the SRP area only of the Landsat scene (Bands 1, 3 & 4). Figure 5 is a thermal composite (Bands 1, 4 & 6) showing thermally altered surface water areas in red (pond in upper right and streams and marshes in lower left).

Since the initial analysis, additional PNL image processing software has been written and tested which provides for more rapid and effective analysis of the Landsat-4, 7 band TM data. Current efforts are directed at analyzing lower resolution HCM data of the area provided by GSFC and the recently received thermal night-time coverage of the Savannah River Plant.

Conferences/Publications: PNL staff has participated in both the Landsat-4 Investigations Workshop and the Landsat-4 Scientific Characterization-Early Results symposium. Because of the lack of TM data over DOE study sites of interest, no publications or presentations have been authored to date.

Current plans include presenting initial results 1) in a Landsat-4 session at IGARSS '83 in San Francisco, CA, August 31 - September 2, 1983, and 2) at the Third National Conference on Resource Management Applications: Energy and Environment immediately preceeding IGARSS '83 in San Francisco on August 23-27, 1983.

Problems: The major problem relates to obtaining the required TM data sets to satisfy increasing DOE interest in using these data for operational and research interests. Because of cloud cover problems typically experienced during the winter in the Pacific Northwest, no useable TM data has been acquired over our prime study site (DOE Hanford site) from the Canadian station prior to the failure of the Landsat-4 downlink. We will be re-evaluating our data quota requirements and resubmitting priorities based on what transpires relative to TDRS performance.



FIGURE 1. False-color IR Composite of TMS data (Bands 1, 2 and 4) for a Nuclear Power Plant (Black Arrow)

ORIGINAL PAGE
COLOR PHOTOGRAPH



FIGURE 2. Thermal Composite of TMS data (Bands 5, 6 and 7) Showing surface water thermal distribution (in red) associated with nuclear power plant cooling (note arrows)

ORIGINAL PAGE IS
OF POOR QUALITY

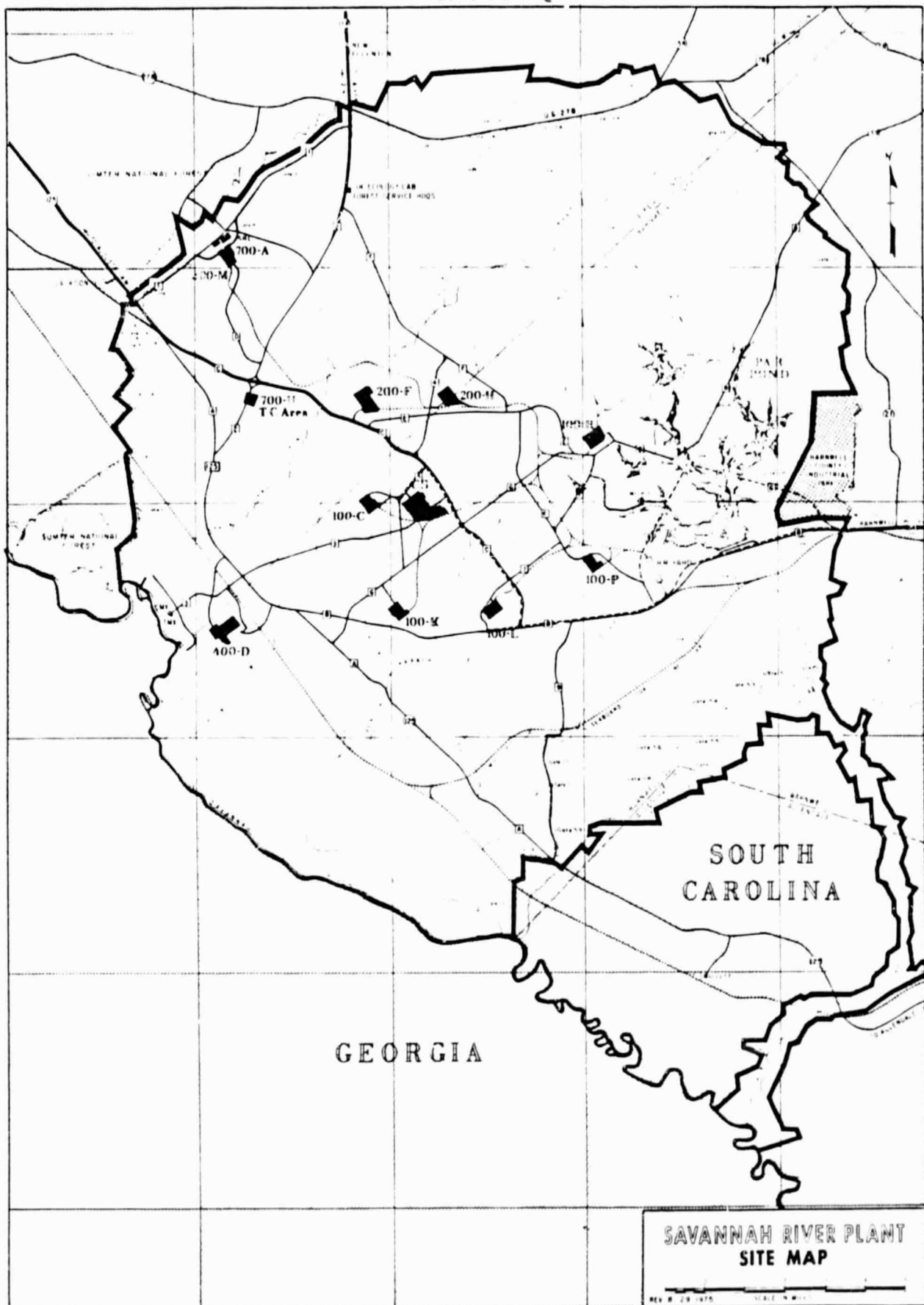


FIGURE 3. General site map for Savannah River Plant.

ORIGINAL PAGE
COLOR PHOTOGRAPH



FIGURE 4. Portion of Landsat-4 color composite (bands 1, 3 and 4) showing Savannah River Plant - August 28, 1982

ORIGINAL PAGE
COLOR PHOTOGRAPH

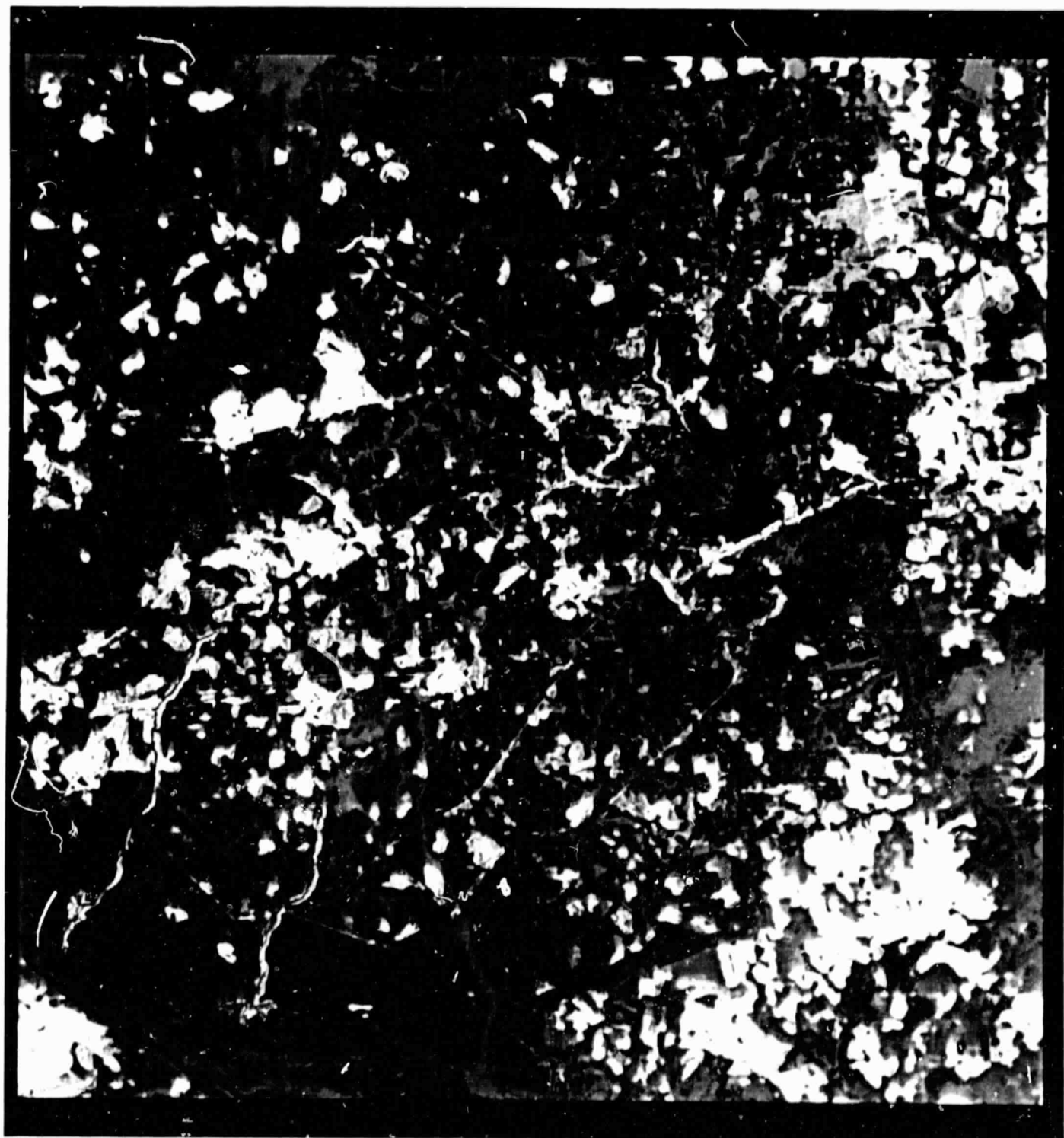


FIGURE 5. Portion of Landsat-4 thermal composite (bands 1, 4, and 6) showing surface waters being used for cooling at SRP. (Bright red areas) August 28, 1982.